Working with nonverbal elements using DGS in mathematics

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1) Explanation of nonverbal items

- **Nonverbal elements or items are understood as a visual representation in this article. But visual representation has many forms.**

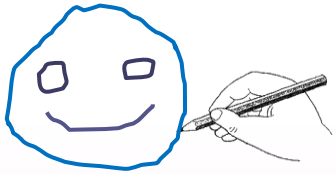
- **Therefore nonverbal elements include the visual representations and tactile visual representations like :**

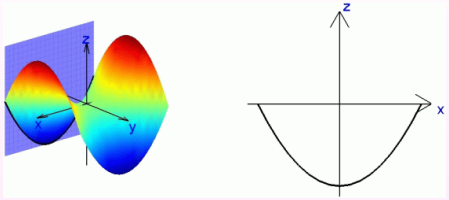
Freehand drawing

Static or dynamic PC objects

Wire or wooden models

Origami





2) The first pilot research results

- **One of the research question of the first research was:**

  Can pupils read nonverbal items and discover the important features from it?

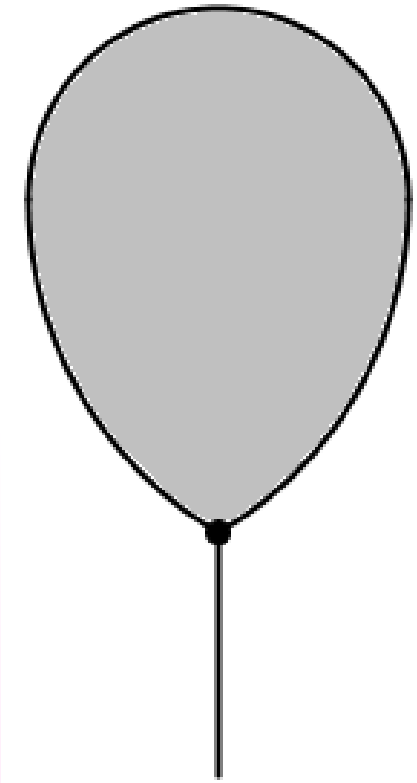
- **Depending on this research question we have made following five tasks.**

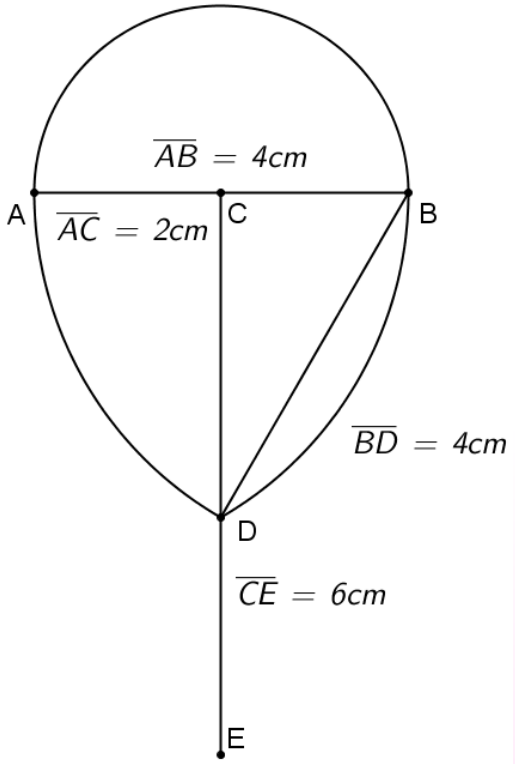
2) The first pilot research results

Pupils must read this visual representation and copy it in right scale with right properties.

Task 1

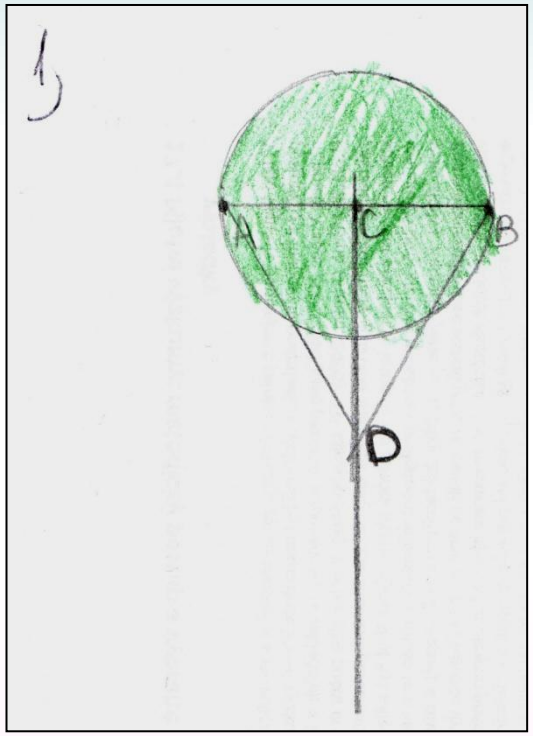
Construct the baloon as shown below. Lengths are given in centimeters.

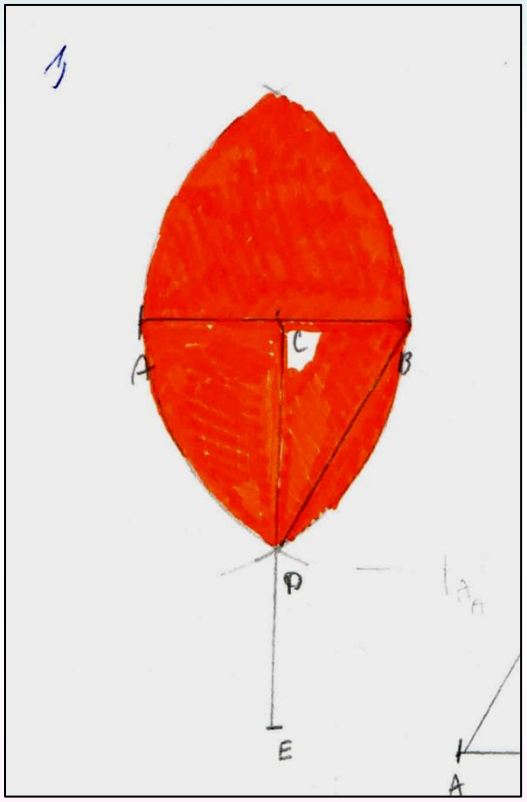




2) The first pilot research results

Two of the wrong pupil's solutions.





2) The first pilot research results

Pupil must draw and name a quadrilateral according to mentioned features.

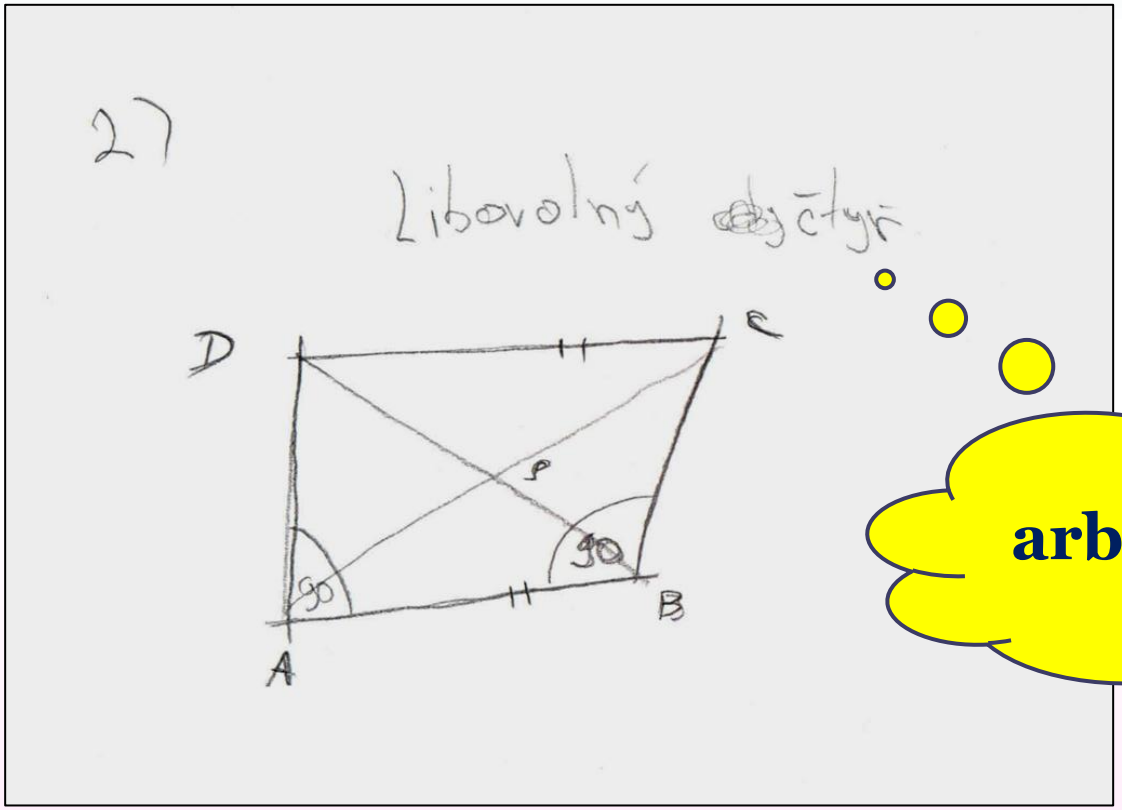
Task 2

Draw and name a geometric shape with the properties that are given below:

It is a geometric shape, whose opposite sides are parallel and congruent. Consecutive angles are different, but they are supplementary. Opposite angles are congruent. The diagonals of this shape bisect each other.

2) The first pilot research results

One of the wrong pupil's solutions.

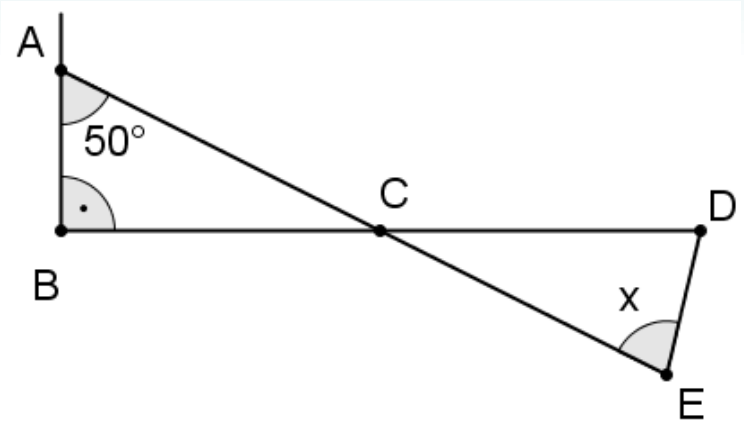


arbitrary quad...

2) The first pilot research results

Pupils must read all important features from the picture and on the basis of these qualities count the angle *x*.

Task 3



There are $|CD| = |CE|$ on the picture.

How many degrees is *x*?

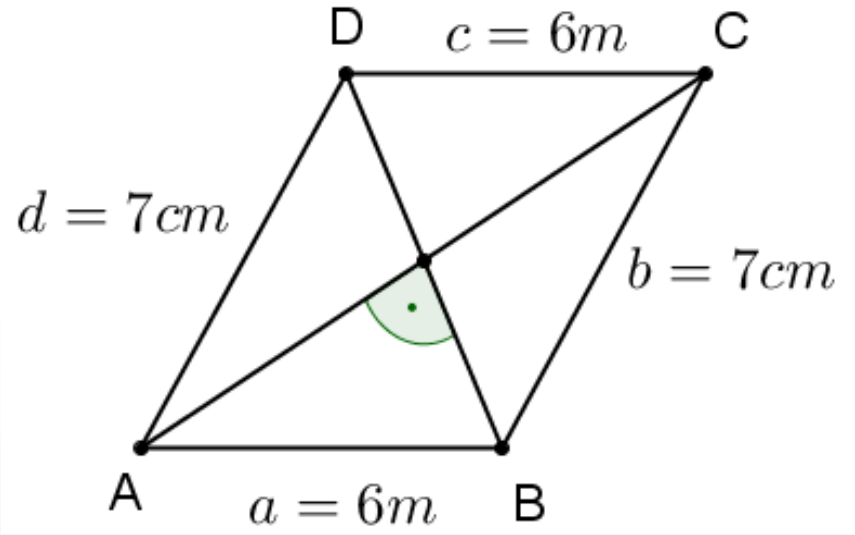
A) 40 B) 50 C) 60 D) 70

2) The first pilot research results

Pupils must find out all features of this visual representation and compare it with all rhomboid's properties.

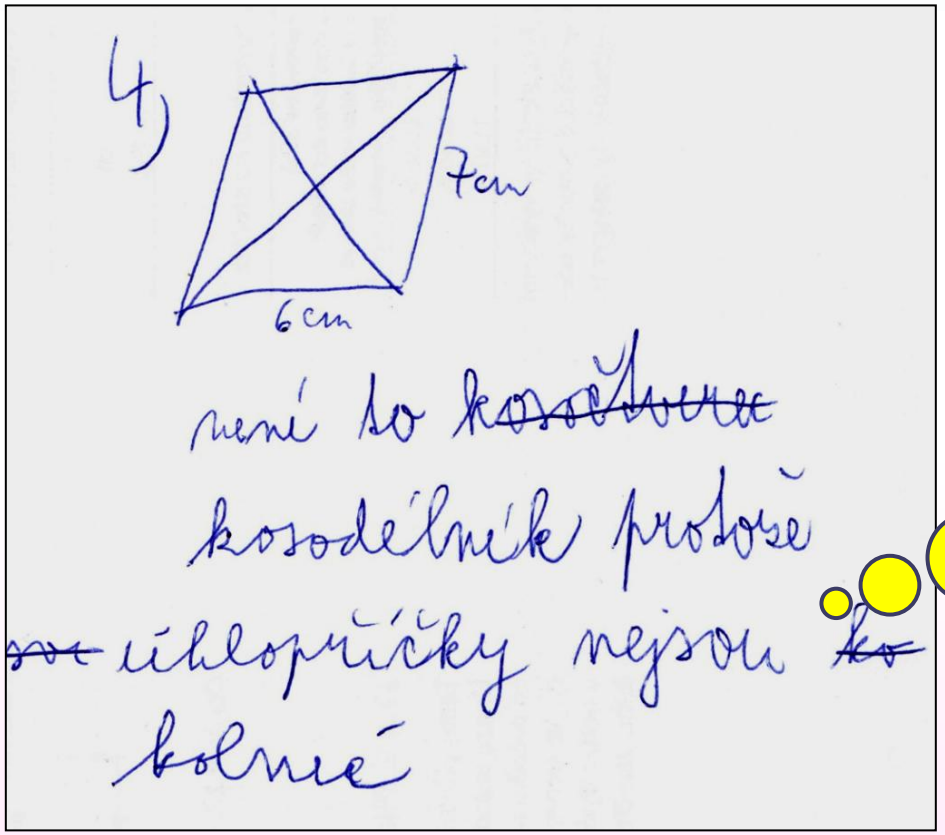
Task 4

Decide if the geometric shape, which is shown below, is a rhomboid. Explain your answer.



2) The first pilot research results

One of the right pupil's solutions.



It can't be a rhomboid because of the perpendicular diagonals.

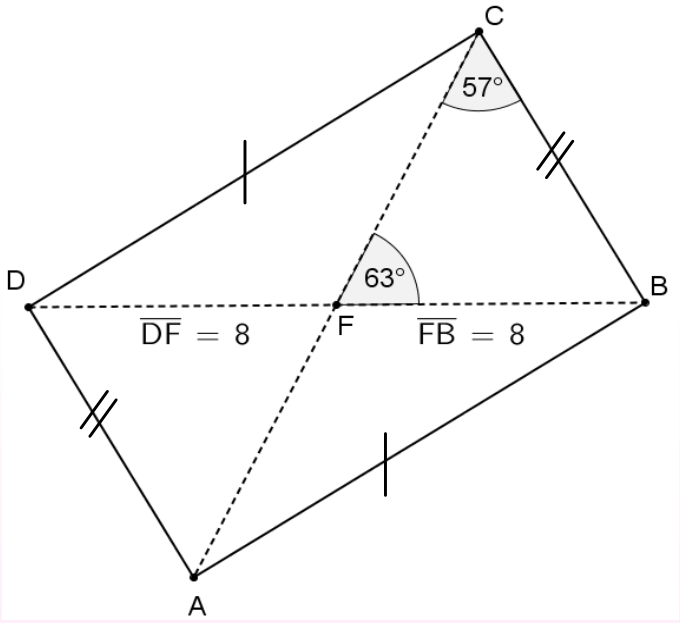
2) The first pilot research results

Pupils must compare the visual representation with quadrilaterals in brackets.

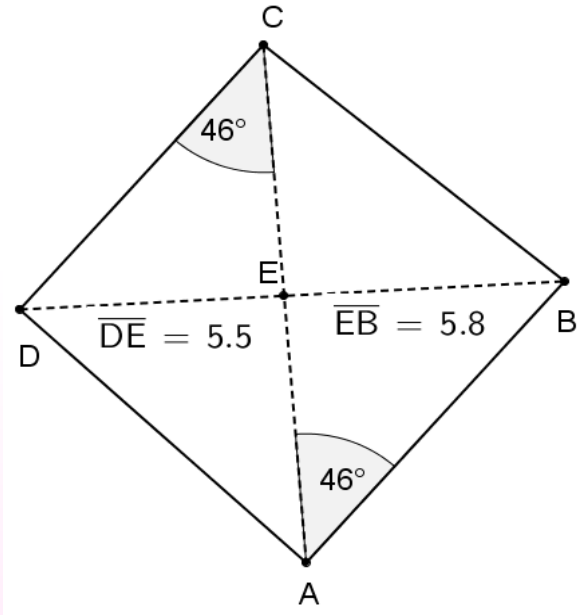
Task 5

Decide and write down what kind of geometric object is on the picture below.
(square, triangle, rhombus, rhomboid, rectangle, tetrahedron, parallelogram, trapezium)

a)

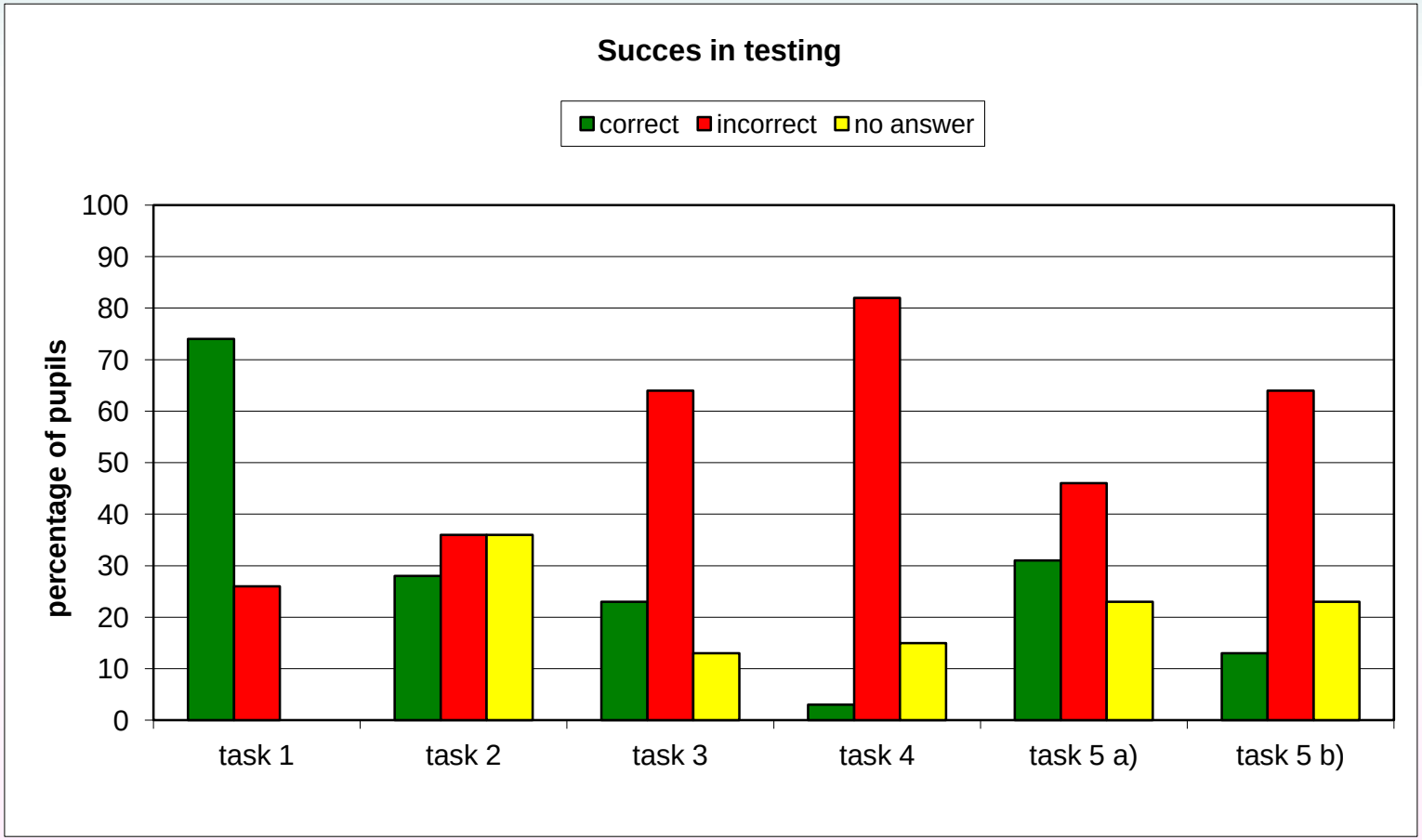


b)



2) The first pilot research results

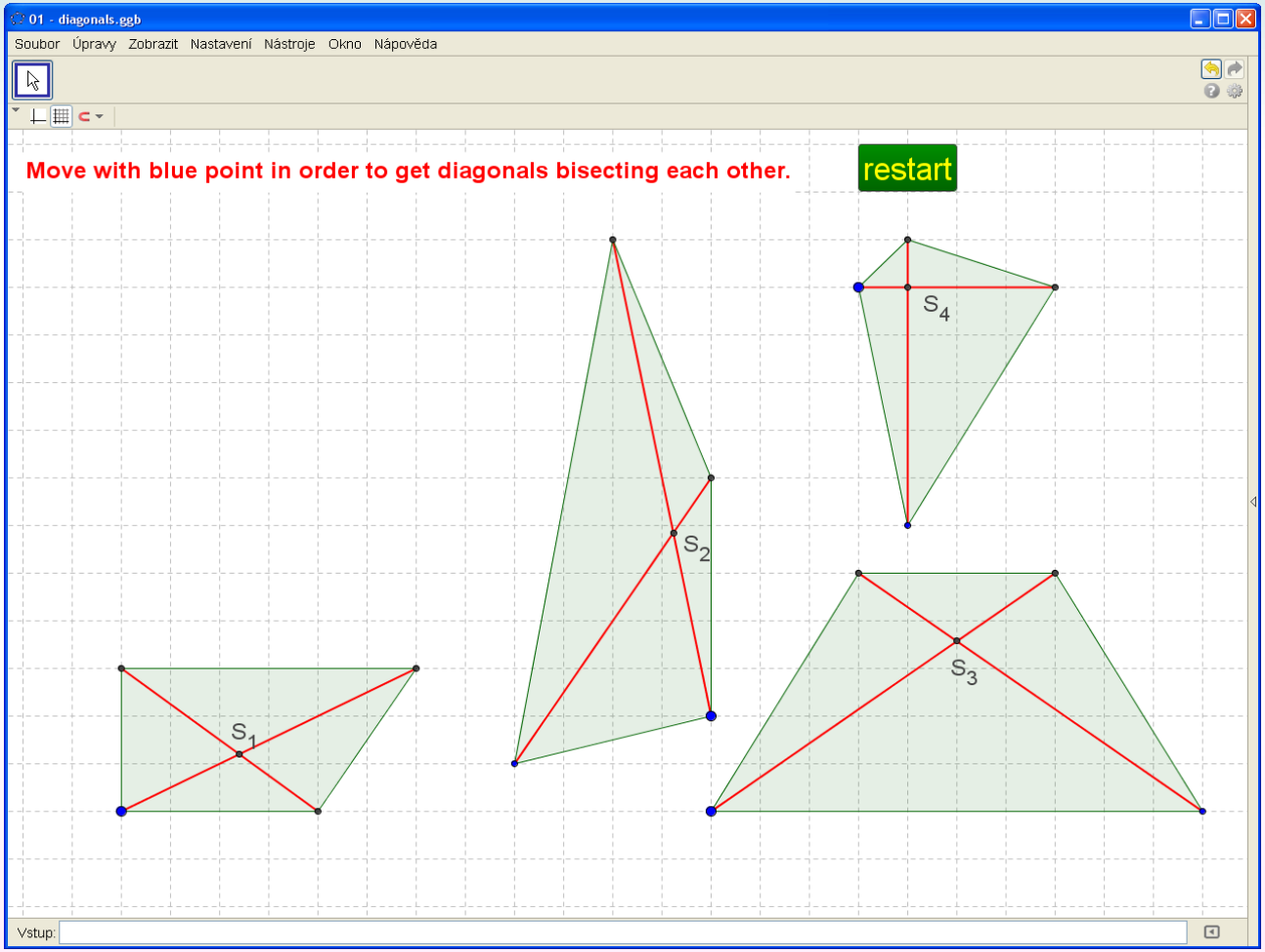
Results of the first research in percentages.



2) The first pilot research results

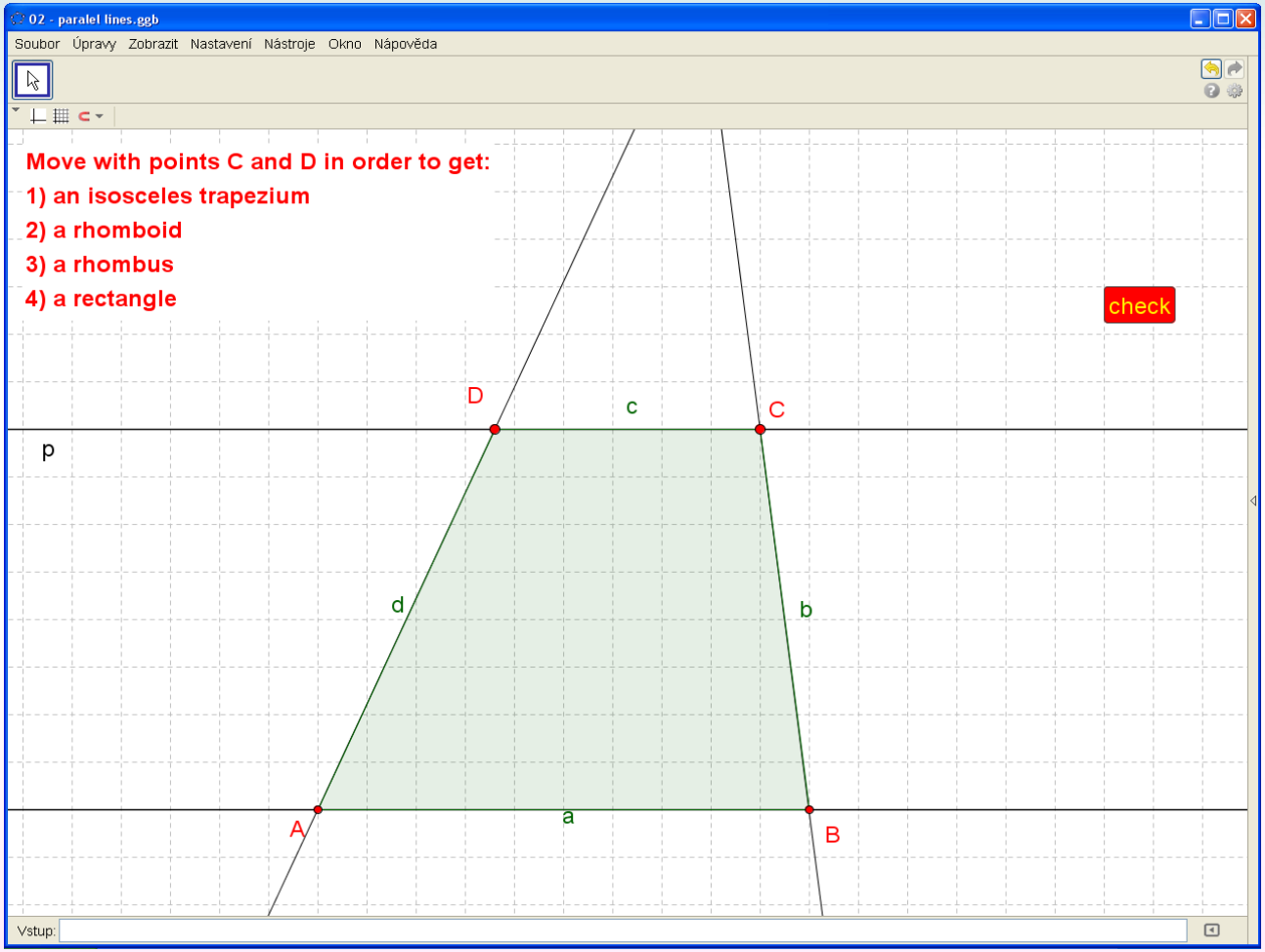
As we can see, the results and graphs of pupil's successful is not too good. Pupils can not read visual representations and can not work with them. It is necessary to continue in research and find out right reasons of this pupil's deficiencies.

3) How can the *GeoGebra* help to achieve a better understanding



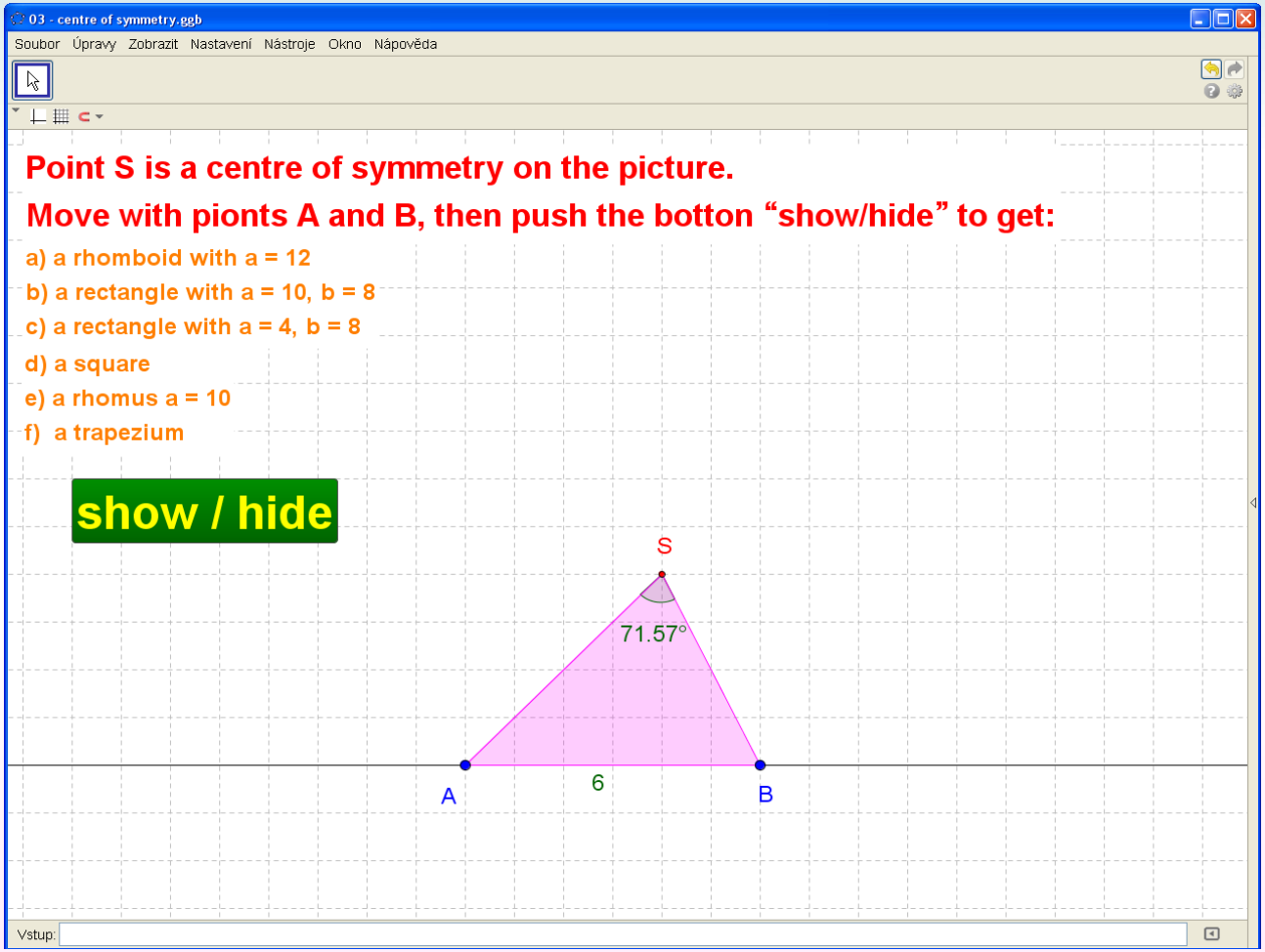
Exercise 1

3) How can the *GeoGebra* help to achieve a better understanding



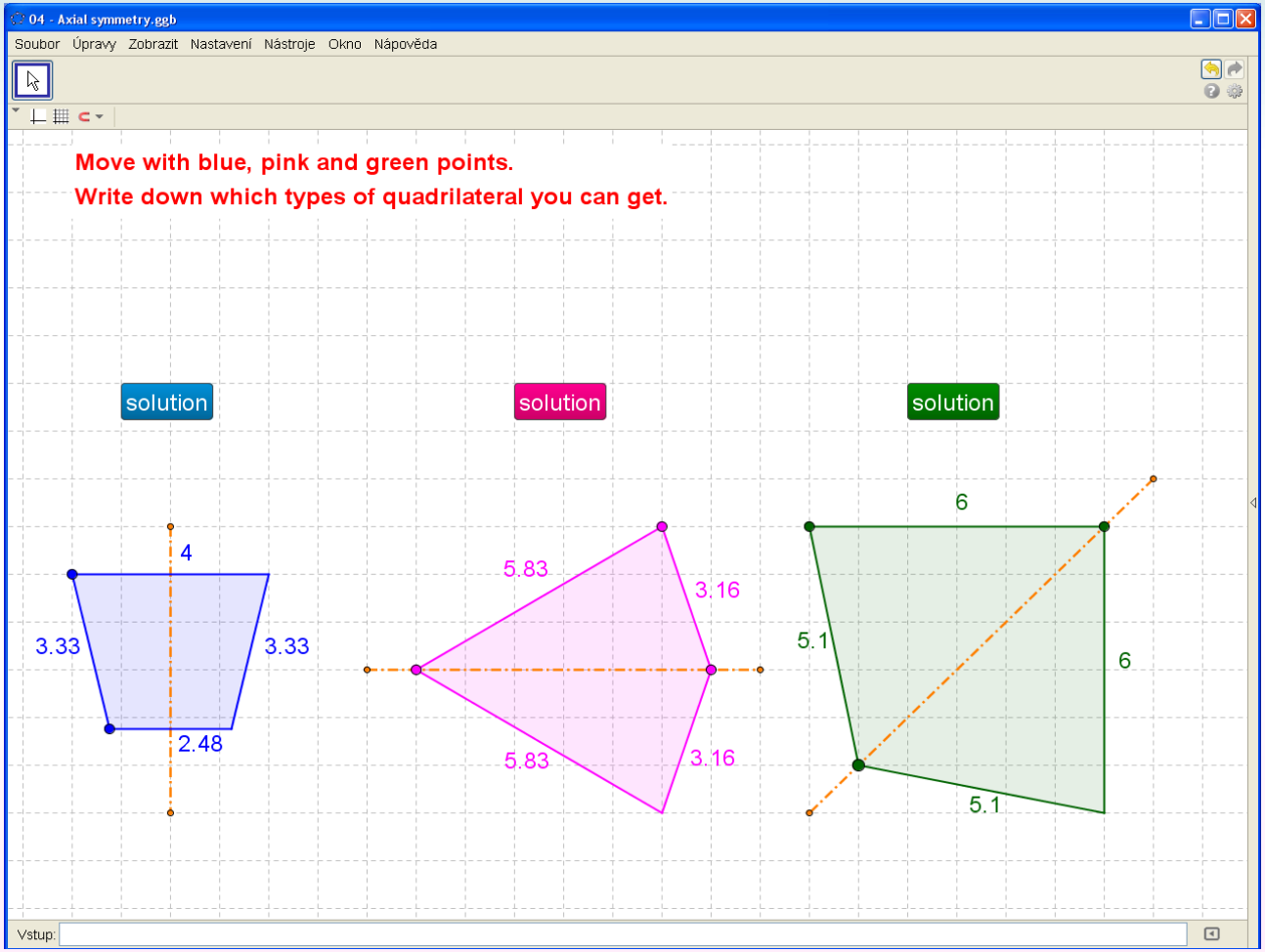
Exercise 2

3) How can the *GeoGebra* help to achieve a better understanding



Exercise 3

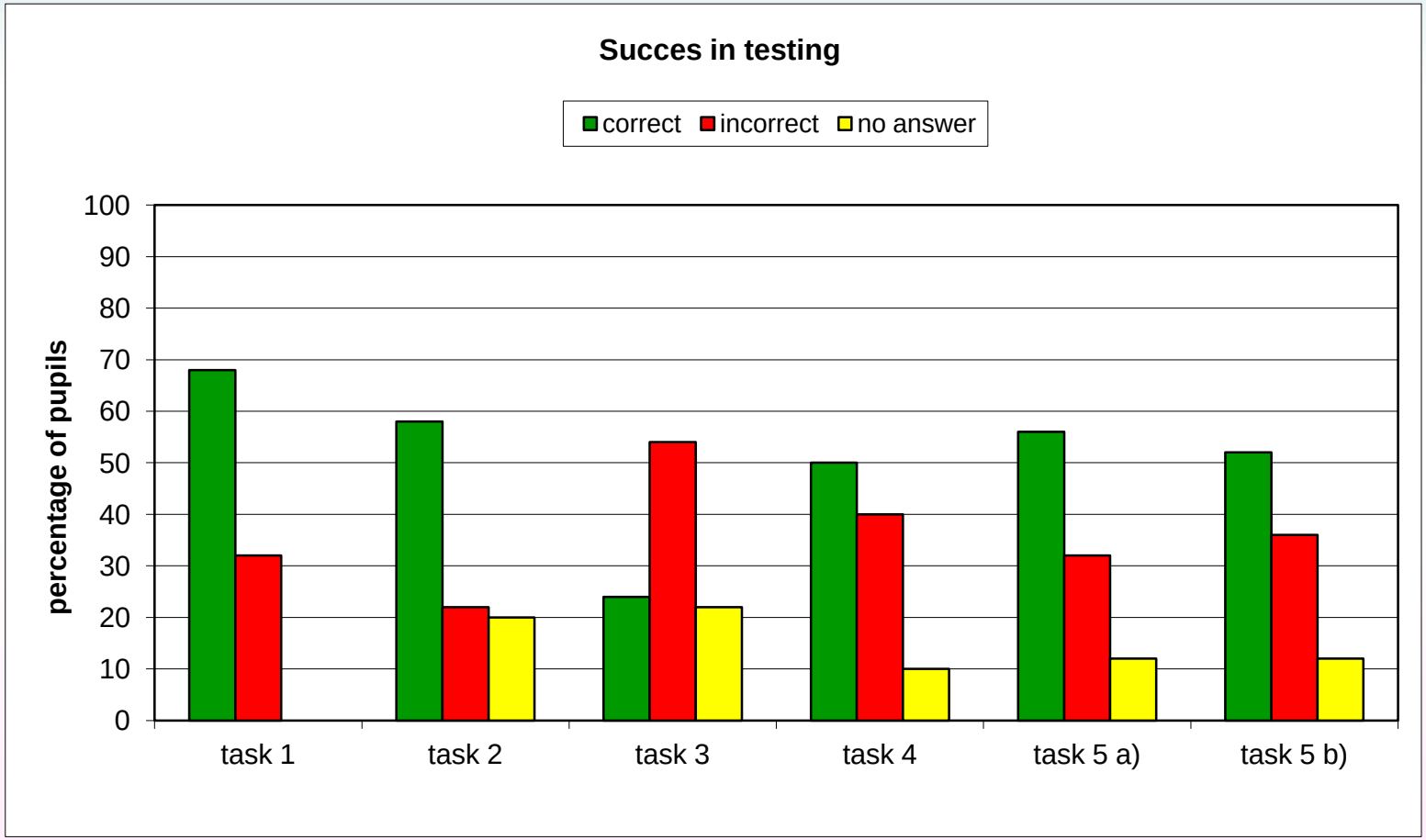
3) How can the *GeoGebra* help to achieve a better understanding



Exercise 4

4) Second pilot research results

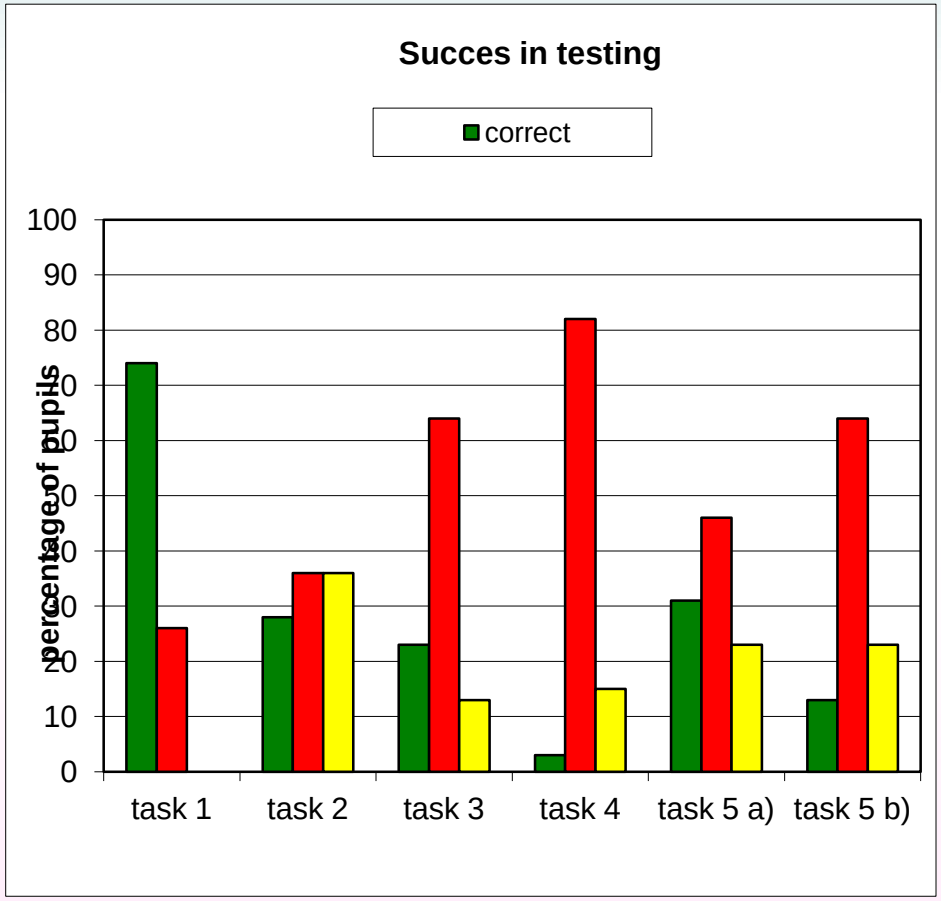
Results of the second research in percentages.



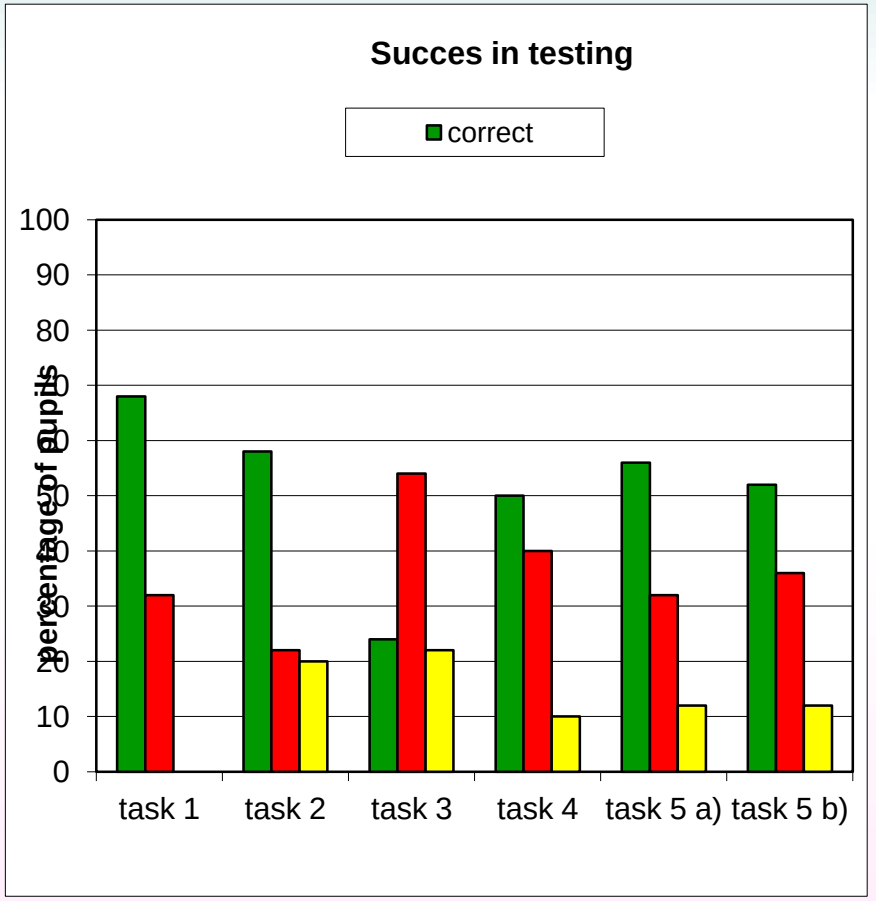
4) Second pilot research results

You can compare both results.

First research



Second research



5) Conclusion

The results imply that the pupils from this second research sample had problems only with the third task, which did not deal with quadrilaterals.

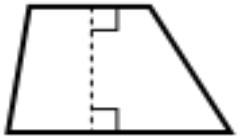
However, there are still some distortions in the pilot research. Further research should focus on

- **a deeper causes of these problems**
- **creating more exercises in *GeoGebra***
- **further testing of a bigger sample for a longer period of time and with more diverse tasks dealing with quadrangles.**

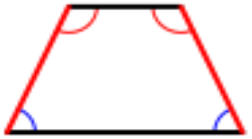
6) Problem with taxonomy of quadrilaterals

Interetsing progblem has appeared during the pilot research. It lies in taxonomy of quadrilaterals. For example there is one chapter about rhomboid in czech schoolbooks. In spite of this, somewhere the rhomboid is not mentioned at all.

Trapezium
(Amer. Eng.)

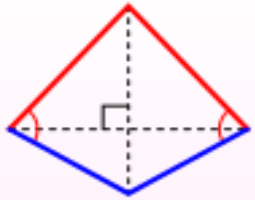


Trapezoid (Amer. Eng.)
Trapezium (Brit. Eng.)



Isosceles trapezoid (Am.)
Isosceles trapezium (Br.)

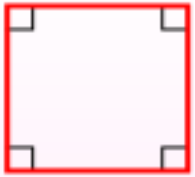
Parallelogram



Kite

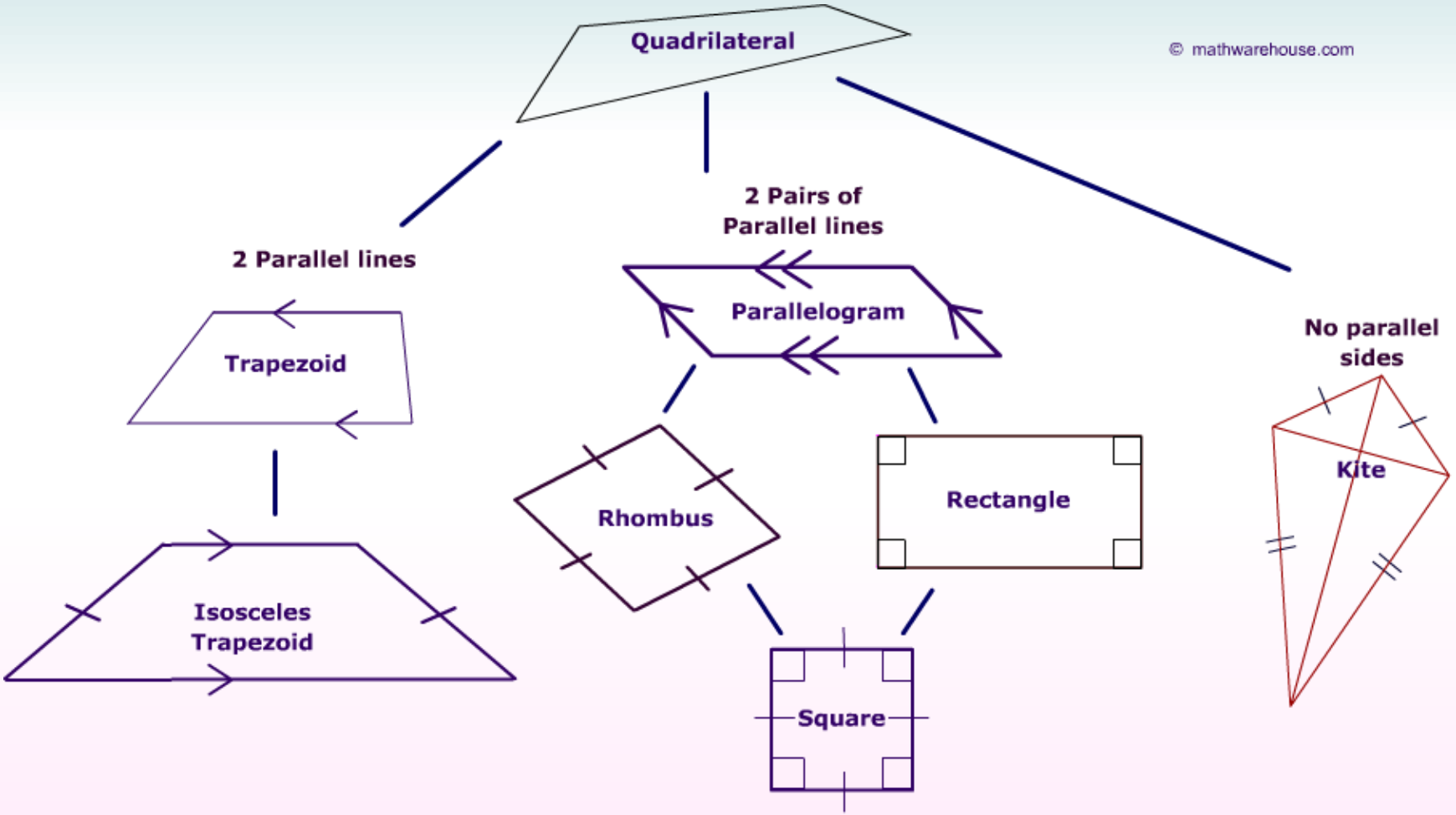
Rhombus

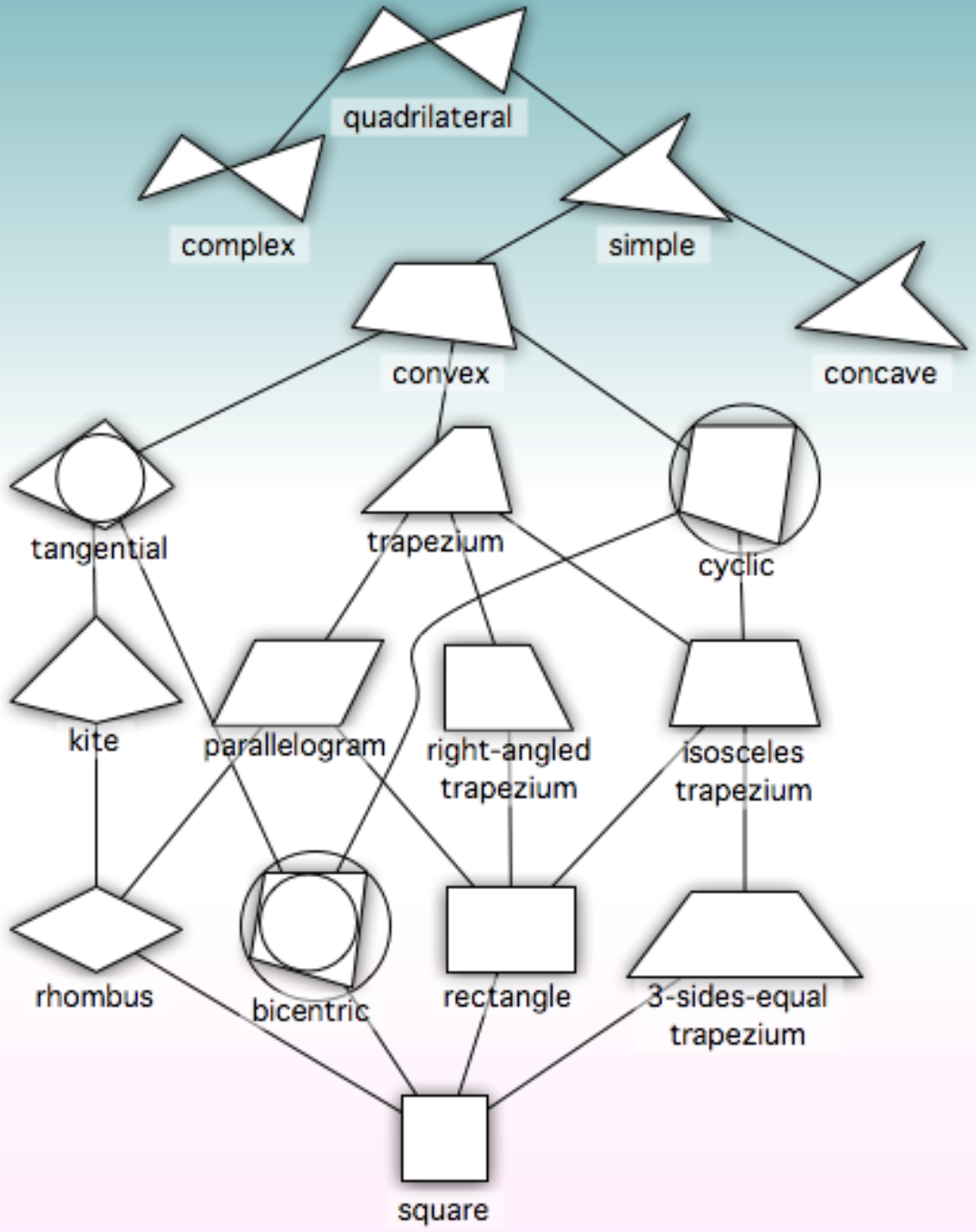
Rectangle



Square

6) Problem with taxonomy of quadrilaterals




quadrilateral
complex
simple
convex
concave
tangential
trapezium
cyclic
kite
parallelogram
right-angled trapezium
isosceles trapezium
rhombus
bicentric
rectangle
3-sides-equal trapezium
square

Thank you for your attention